CLAIMS

1. In direct sequence spread spectrum (DSSS) communications, a method for recovering system timing, the method

5   comprising:

estimating a sleep clock frequency;

disabling a reference clock during a sleep interval;

following the sleep interval, enabling the reference clock;

advancing the system timing by a ratio, where the ratio is

10   the reference clock frequency divided by the sleep clock frequency; and

calculating the ratio in response to frequency drift of the

sleep clock.

2. The method of claim 1 further comprising:

15   measuring a reacquisition error; and

wherein calculating the ratio includes calculating the ratio in

response to the reacquisition error.

3. The method of claim 2 further comprising:

20   determining the frequency drift of the sleep clock.

4. The method of claim 3 further comprising:

prior to disabling the reference clock, determining the

number of sleep clock periods in the sleep interval; and

wherein disabling reference clock during the sleep interval includes disabling the reference clock for the determined number of sleep clock periods.

5.   The method of claim 4 wherein determining the number of sleep clock periods in the sleep interval includes determining the number of sleep clock periods using the ratio.

6.   The method of claim 5 in which the sleep clock and reference clock have nominal frequencies;

wherein determining the number of sleep clock periods in the sleep interval includes multiplying the sleep interval, times the nominal reference clock frequency, times the inverse of the ratio as follows:

$$N_{sleep\_clk} = T_{sleep} \times f_{ref} \times (1/R)$$
$$= T_{sleep} \times f_{ref} \times (f_{sleep}'/f_{ref}').$$

7.   The method of claim 6 wherein determining the number of sleep clock periods in the sleep interval includes rounding the number of sleep periods down to an integer value of sleep clock periods.

8.   The method of claim 6 wherein advancing the system timing includes advancing the system timing by the product of the number of sleep clock periods in the sleep interval and the ratio as follows:

$$N_{ref\_clk\_adj} = N_{sleep\_clk} \times R$$

$$= T_{sleep} \times f_{ref} \times (f_{sleep}'/f_{ref}') \times (f_{ref}'/f_{sleep}').$$

9. The method of claim 8 wherein advancing the system timing by the product of the number of sleep clock periods and the ratio includes rounding the product down.

10. The method of claim 8 further comprising:

performing an initial calculation of the ratio over an extended period of time.

11. The method of claim 10 wherein performing an initial calculation includes calculating the ratio by averaging the number of rising and falling edges in a reference clock signal to determine an averaged ratio.

12. The method of claim 8 wherein determining the drift of the sleep clock frequency during the sleep interval includes approximating the sleep clock frequency drift with a linear function including the ratio as follows:

$$\Delta f_{sleep} = (R - r_0) / b$$

where the r_0 and b are constants.

13.   The method of claim 12 wherein determining the drift of the sleep clock includes adding the frequency drift during the last sleep interval to the accumulated sleep clock frequency drift to obtain the sleep

5   clock frequency drift with respect to the nominal sleep clock frequency.

14.   The method of claim 13 in which a received PN code sequence is accepted in the DSSS communications;

wherein advancing the system timing includes shifting the

10   phase of the PN code sequence; and

the method further comprising:

following the shifting of the phase of the PN code sequence, reacquiring the system time using the shifted PN code sequence and the received PN code sequence; and

15   wherein, following the measuring of the reacquisition error, modifying the sleep clock frequency drift determination is modified in response to the reacquisition error.

15.   The method of claim 14 wherein measuring the

20   reacquisition error includes measuring the offset between the center of a searching window and correct timing position, δc; and

wherein determining the sleep clock frequency drift includes calculating the sleep clock frequency drift during the previous sleep period T_{sleep} with a linear approximation of the function $\Delta f_{sleep} = f(\delta c)$, as follows:

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$$\Delta f_{sleep} = (\delta c - c_0) / d$$

where c_0 and d are constants.

5   16.   In direct sequence spread spectrum (DSSS)

communications, a method for recovering system timing, the method

comprising:

measuring sleep clock frequency using an initial ratio;

disabling a reference clock during a sleep interval;

10   following the sleep interval, enabling the reference clock;

advancing the system timing in response to the ratio;

measuring the reference clock frequency and the sleep clock

frequency to supply a current ratio; and

determining a ratio in response to a previous ratio and the

15   current ratio.

17.   The method of claim 16 further comprising:

measuring the reacquisition error; and

wherein determining the ratio in response to the previous

20   ratio and the current ratio includes weighting the importance of the

current ratio and previous ratio in response to the reacquisition error.

18.   The method of claim 17 further comprising:

performing a calibration measurement of the ratio over an

25   extended period of time; and

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wherein measuring the sleep clock frequency using the initial ratio includes using the ratio measured over an extended period of time as the initial ratio.

5   19.   The method of claim 18 in which the sleep interval is provided;

the method further comprising:

determining the number of sleep clock periods in the sleep interval; and

10   wherein disabling the reference clock frequency during the sleep interval includes disabling the reference clock for the determined number of sleep clock periods.

20.   The method of claim 19 wherein determining the

15 number of sleep clock periods in the sleep interval includes determining the number of sleep clock periods using the ratio.

21.   The method of claim 20 wherein measuring the current ratio includes averaging the number of rising and falling edges in

20 the reference clock frequency, to determine an averaged ratio; and

wherein measuring the current ratio includes using the averaged ratio.

22.   The method of claim 21 in which the sleep clock and

25 reference clock have nominal frequencies;

wherein determining the number of sleep clock periods in the sleep interval includes multiplying the sleep interval times the nominal reference clock frequency, times the inverse of the ratio as follows:

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$$N_{sleep\_clk} = T_{sleep} \times f_{ref} \times (1/R)$$
$$= T_{sleep} \times f_{ref} \times (f_{sleep}'/f_{ref}').$$

23. The method of claim 22 wherein determining the number of sleep clock periods in the sleep interval includes rounding the

10 number of sleep periods down to an integer value of sleep clock periods.

24. The method of claim 22 wherein advancing the system timing by the product of the number of sleep clock periods and the ratio includes finding the product as follows:

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$$N_{ref\_clk\_adj} = N_{sleep\_clk} \times R$$
$$= T_{sleep} \times f_{ref} \times (f_{sleep}'/f_{ref}') \times (f_{ref}'/f_{sleep}').$$

25. The method of claim 24 wherein advancing the system

20 timing by the product of the number of sleep clock periods and the ratio includes rounding the product down to an integer value.

26. The method of claim 16 further comprising:

wherein determining the ratio includes determining the ratio

25 in response to a plurality of previous ratios and the current ratio.

27.   In direct sequence spread spectrum (DSSS) communications network, a receiver system for recovering system timing, the receiver system comprising:

5   a clock system having a first output to provide a reference clock signal with a reference clock frequency and a second output to supply a PN code sequence, the clock system having a first input to accept commands to enable and disable the reference clock and a second input to accept system timing advancement commands;

10   a sleep clock having an output to provide a sleep clock signal with a sleep clock frequency, less than the reference clock frequency; and

           a controller having a first input connected to the clock system first output, a second input connected to the sleep clock output, and a third input to receive reacquisition errors, the controller having a first

15   output connected to the first input of the clock system to disable the reference clock during a sleep interval and to enable the reference clock after the sleep interval, the controller having a second output connected to the second input of the clock system to advance the system timing in response to determining the ratio of reference clock frequency and sleep

20   clock frequency.

28.   The system of claim 27 further comprising:

           a searcher having a first input connected to the clock system output to accept a PN code sequence, a second input to accept a received

25   PN code sequence, the searcher reacquiring the received PN code

sequence from the clock system shifted PN code sequence, the searcher having an output to supply measured reacquisition errors.

29. The system of claim 28 wherein the controller uses the reacquisition error to derive the frequency drift of the sleep clock frequency.

30. The system of claim 29 wherein the controller, in response to deriving the frequency drift of the sleep clock, derives the actual time of the sleep interval.

31. The system of claim 30 wherein the controller has a fourth input to accept the sleep interval, the controller determining the number of sleep clock periods in the sleep interval and disabling the reference clock for the determined number of sleep clock periods.

32. The system of claim 31 wherein the controller determines the number of sleep clock periods in the sleep interval by using the ratio.

33. The system of claim 32 wherein a nominal sleep clock frequency and a nominal reference clock frequency are included; and

wherein the controller determines the number of sleep clock periods in the sleep interval by multiplying the sleep interval times the

nominal reference clock frequency, times the inverse of the ratio as follows:

$$N_{sleep\_clk} = \lfloor T_{sleep} \times f_{ref} \times (1/R) \rfloor$$

$$= \lfloor T_{sleep} \times f_{ref} \times (f_{sleep}'/f_{ref}') \rfloor.$$

34. The system of claim 33 wherein the controller advances the system timing by finding the product of the number of sleep clock periods times the ratio as follows:

$$N_{ref\_clk\_adj} = \lfloor N_{sleep\_clk} \times R \rfloor$$

$$= \lfloor \lfloor T_{sleep} \times f_{ref} \times (f_{sleep}'/f_{ref}') \rfloor \times (f_{ref}'/f_{sleep}') \rfloor.$$

35. The system of claim 34 wherein the controller averages the number of rising and falling edges in the reference clock signal over an extended period of time to determine an averaged ratio; and

wherein the controller uses the averaged ratio as the initial ratio.

36. The system of claim 34 wherein the controller determines the drift of the sleep clock frequency during the sleep interval by dividing the nominal reference clock frequency by the product of the nominal sleep clock frequency times the ratio, minus one as follows:

$$\Delta f_{sleep} = f_{ref} / \ (f_{sleep} \ R) - 1.$$

37. The system of claim 36 wherein the controller determines the drift of the sleep clock frequency during the sleep interval by approximating the sleep clock frequency drift with a linear function including the ratio as follows:

$$\Delta f_{sleep} = (R - r_0) / b$$

where the r_0 and b are constants.

38. The system of claim 37 wherein the clock system includes a PN code sequence generator operating at a PN generator clock rate, proportionally related to the reference clock frequency; and
wherein the controller advances the system timing by shifting the phase of the PN code sequence.

39. The system of claim 38 wherein the searcher measures the reacquisition error by measuring the offset between the center of a searching window and correct timing position, δc; and
wherein the controller calculates the sleep clock frequency drift during the previous sleep period T_{sleep} with a linear approximation of the function $\Delta f_{sleep} = f(\delta c)$, as follows:

$$\Delta f_{sleep} = (\delta c - c_0) / d$$

where c_0 and d are constants.

40. The system of claim 28 wherein the controller determines the ratio in response to a previous ratio and a current ratio.

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41. The system of claim 28 wherein the controller determines the ratio in response to a plurality of previous ratios and the current ratio.

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42. The system of claim 40 wherein the controller, following the enabling of the reference clock frequency, measures the reacquisition error, and the controller determining the ratio by weighting the importance of current ratio and previous ratio in response to the reacquisition error.

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43. The system of claim 42 wherein the controller performs a calibration measurement of the ratio over an extended period of time, and uses the calibration measurement as the initial ratio.

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44. The system of claim 43 wherein the controller measures the ratio by averaging the number of rising and falling edges in the reference clock signal to determine an averaged ratio, and determines the current ratio by using the averaged ratio.